SHAFT-SINKING BY FREEZING.

THE method of shaft-sinking recently invented by Mr. F. H. Poetsch of Aschersleben, by means of the artificial production of low temperatures, is an illustration of the new and unexpected directions in which chemical and physical processes become of use. In sinking shafts for mining and other engineering purposes, and in the construction of deep foundations, the presence of quicksand has always been dreaded; for it can be penetrated, if at all, only with great difficulty and expense. While the use of compressed air has enabled us to sink shafts and place foundations in water-bearing strata, we are limited to depths not much exceeding one hundred feet by the practical inability of the human system to endure greater air-pressures. Mr. Poetsch has successfully applied to such cases a method of shaft-sinking by freezing, which bids fair to remove all the trouble. He proposes to do away with the pumps and air-compressors, to transform the surrounding liquid soil into a solid wall of ice, and in this way to reduce the problem of shaft-sinking to that of work in hard, dry ground.

A system of tubes is sunk around and within the site of the proposed shaft, and a saline solution such as chloride of calcium, of very low temperature, having for its freezing-point — 40° F., and passed through a Carré ice-machine, is caused to circulate through the system by means of inner tubes until the semi-fluid soil is solidified by congelation. The temperature of the ground has been reduced, in actual work, from 52° F. to 0° F. in twenty days, freezing within a circle of about five feet diameter around each pipe, and producing in the quicksand the solidity of sandstone, with all its properties of stability, and a conchoidal fracture.

The method of putting in place the freezing-pipes varies with the locality. When the quicksand has a slight thickness only, and the shaft is already sunk to the water-level, the pipes are simply forced into the sand with a sand-pump working inside. This was the system actually employed at the Archibald mine, near Schneidlingen, Prussia, where twenty-three pipes nearly eight inches in diameter were sunk through a water-bearing stratum eighteen feet thick, and at the Max mine, near Michalkowitz, Upper Silesia. In other cases a boring-machine is used which puts down four pipes at a time, and is worked by the water-jet system. If the fluid soil lies at no great depth, the holes for the pipes are bored from the surface, and the pipes are so arranged that the shaft can be sunk inside of them; but, when the water-stratum is at a great depth below the surface, a shaft of some three feet greater diameter than the finished shaft is first sunk through the firm ground, so as to permit of the sinking of the pipes through the fluid stratum, and the construction of the final shaft within them.

At the Centrum mine, near Berlin, one hundred and seven feet of quicksand had to be penetrated. Engineers had been baffled for years in their attempts to overcome the difficulties. In thirty-three days, with sixteen pipes, Mr. Poetsch had secured a wall of ice six feet thick around the shaft area, and the shaft is now being excavated and curbed without special difficulty.

A series of bridge-piers is to be sunk by this method near Bucharest, Austria. This last contract has especial interest; as it will afford a test of the seemingly just claim of the inventor, that his plan opens up great possibilities in founding bridge-piers. As opposed to the compressed-air process, the main advantages are in the practical absence of limitation in depth, and the relief of the laborers from the effects of severe air-pressures. The entire plant can be used repeatedly, as the pipes can be withdrawn as soon as the ground thaws out. The cost of an undertaking can also be estimated in advance with reasonable certainty.

A more detailed description of this process is given in the *Engineering news*, June 7, 1884, based on an article from the *Zeitschrift für berg., hutten., und salinenwesen in Preussischen staate*, and in the *Engineering news*, July 5, 1884, with illustrations of the plant used at the Centrum mine.

CHAS. E. GREENE.

AMERICAN ORIENTAL SOCIETY.

THE American oriental society held its autumn meeting at the Johns Hopkins university in Baltimore on Wednesday and Thursday, Oct. 29 and 30. A grammar of the Siamese language was reported as nearly finished by one of the members, Rev. S. C. George. A vocabulary of the Mortlock dialect had been offered to the society for publication by a missionary in the Caroline Islands, and a translation of the Prem Sagar from the original Hindi by the Rev. J. M. Jamieson. The Peking missionary association sent resolutions respecting the eminent Sinologue, Dr. S. W. Williams, the lately deceased president of the Oriental society.

Fourteen papers were presented to the society. The extreme east was represented by a paper on the Korean numerals and alphabet. Mr. Rockhill, an *attaché* of the U. S. embassy to China, presented to the library a Tibetan book of poems by Milaraspa, a Buddhist missionary of the eleventh century; and his paper gave an account of the work, with specimen translations. The president of the society, Professor Whitney of Yale, discussed a group of aorist-forms in Sanscrit. The forms in question are of especial interest, inasmuch as they furnish a good test-case for the general trustworthiness of the Hindu science of grammar, as compared with the most modern treatment of the subject. Professor Bloomfield of Johns Hopkins discussed the position of the Vaitana sutra in the literature of the Atharva-veda, an important text of which, the Kauçika sutra, he is now editing. Several Syriac and Hebrew papers of value were presented; but we must pass them by for want of sufficient space.

In Assyriology, finally, there was an account by Professor Lyon of Harvard, of the last instalment of

the cuneiform inscriptions of western Asia. This contains a great deal of linguistic and historical material; e.g., a list of four hundred and eighty Assyrian verbs so arranged as to show an aquaintance with an *alphabet* on the part of the writer. We find, first, a series of groups of verbs whose first and second consonants are the same; and, secondly, within these groups, they are arranged according to their final consonant. This is the first inscription showing alphabetic order, and the alphabet is substantially the same as the Hebrew. Unfortunately the tablet is not dated. There is also an historical tablet of Nabunaid or Nabonetus, who was king when Cyrus took Babylon. Nabunaid tells how he restored the temple of the sun-god, and states that in renewing the foundations he discovered an old inscribed tablet that had been placed there by Naram-Sin, thirty-two hundred years before his own day, i.e., about 3750 B.C. The interest in archeology, therefore, is itself something very ancient.

TAIT'S LIGHT.

Light. By P. G. TAIT. Edinburgh, *Adam and Charles Black*, 1884. 8+276 p. 8°.

THIS book, uniform with 'Heat' by the same author, possesses in an eminent degree the qualities which render all books from Professor Tait eagerly welcomed by students of physical science. Although written primarily for the use of university students, it contains much which would interest and instruct one who has never pursued a definite course of study in physics, while there is not a little which will demand close attention from even a well-equipped student.

The first chapter gives a brief but perspicuous historical sketch of the discoveries in the science of light, down to the work of Alhazen. This is followed by chapters on the sources of light, and an admirable treatment of the consequences of the rectilinear propagation of light-waves. Chapter vi. treats of the speed of light. Chapters vii. to x. inclusive are devoted to the phenomena of reflection and refraction. Of notable excellence in the last of these, is the discussion of the rainbow and halos.

The eleventh chapter, doubtless, contains most that is novel to the general reader; for in it is an explanation of refractions in a non-homogeneous medium, including as special cases the phenomena of mirage. For the solution of the most interesting problems presented by these frequently recurring phenomena, we are indebted to Professor Tait more than to any other investigator; and probably no other writer could give in such a simple form so clear a presentation of the subject. The last section of this chapter the author devotes to a eulogy on his master, Sir W. R. Hamilton, and an emphatic assertion of the necessity of extended mathematical study for the student of physics. This concluding paragraph is as important as it is characteristic in style, and may well be quoted. It reads as follows: —

> "We have thought it absolutely necessary to point out, even in an elementary work like this, that such a perfectly general method [Hamilton's principle of varying action] has been developed; but the few fragmentary illustrations of it, which alone can be given without the use of higher mathematics, are so inadequate to the proper exhibition of its power, that we do not give them here. We have said enough to show that any one who wishes really to know the science as it now stands must previously prepare himself by properly extended mathematical study. When he is possessed of this indispensable instrument, he may boldly attack the precious stores of knowledge already accumulated. There is, as yet, no admission to any but those possessed of this master-key."

Fluorescence and absorption, with the attendant phenomenon of anomalous dispersion, form the subject-matter of chapter xii., which contains a highly interesting extract from a recent letter by Professor Stokes on the subject of fluorescence. The next chapter introduces the undulatory theory of light; the remainder of the book being a development of its consequences, including, in the final chapter (xvi.), radiation and spectrum analysis. An appendix contains, 1°, Hamilton on theories of light; 2°, Huygens on rays; and, 3°, the well-known and astonishing letter of Laplace to Young, on the undulatory theory. An index closes the volume.

Though the book is, perhaps, the most important acquisition to the literature of its class for a number of years, there is one particular in which we could have looked for something better. The theory of lenses given is the old one, which has hardly been improved since the time of Kepler, and which is repeated in all English elementary works on physics. By it the approximations are so very imperfect that they are next to useless in practice; while, by employing Gauss's improvements in the theory, formulas no more complicated in form, and hardly more difficult in derivation, could be given, which are of the greatest utility. It has long been the practice in German works, written for students no more advanced than those who will be the readers of this work, to give the Gaussian theory; and it is not easy to see why English writers should have been so slow in adopting it.